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# Countrywide analysis of perinatal outcome

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## 1 Introduction

One of the important areas for the use of computers in perinatal medicine is in the countrywide analysis of perinatal care. The objective would be to use the results to prepare an optimal strategy in order to achieve further improvement in perinatal care. Besides its use for research and clinical work the computer laboratory of our Institute provides national perinatal surveillance and performs a detailed annual analysis of perinatal care in the Czech Socialist Republic (ČSR). ČSR, a country with 10 million inhabitants is one part of Czechoslovakia which has a total of 15 millions inhabitants, and is divided into 8 provinces. The ratio of obstetricians who provide complete antenatal and intranatal care and of neonatologists who take care of the newborns to the total population is similar in each of the 8 provinces. There is also a similar ratio of obstetric and neonatal beds to the population of each province. Of the pregnant women all have antenatal care and 100% of deliveries take place in the labour suites of district, regional and university hospitals.

## 2 Results of the analysis

In spite of the uniformly organized perinatal care, there exist differences in the total perinatal mortality rate (PMR) between individual provinces such that compared to a countrywide average in 1986 of 10.9/1000 these fluctuate between 8.5 and 14.0 (table I). The highest PMR is found especially in those provinces in which there is most industrialisation i.e. West-Bohemia, North-Bohemia and North-Moravia and also in the country's capital – Prague. Compared with countries with low PMR in the rest of world, the cause of the higher PMR in ČSR is not due to late fetal death. The countrywide average of the fetal death rate (LFDR) of 4.2/1000 is one of the lowest in the world. Similarly, the contribution of non-viable malformations to the PMR with a countrywide average of 2.3/1000 does not exceed the values found in other countries. In contrast, however, the early neonatal death rate (ENDR) is high in that the countrywide average of 6.7/1000 is twice as high as that found in the countries with the lowest PMR. The major contribution to this mortality is from the low birth weight (LBW) newborns. The LBW rate in individual provinces varies between 5.2 and 6.9%. Higher frequencies than the countrywide average of 5.8% are again found in those provinces which are more heavily industrialised and also in Prague. Though this difference is seen in all weight categories it is not obvious in those newborns who vere of Very Low Birth Weight ($\leqslant$ 1500 g) and Extremely LBW ($\leqslant$ 1000 g), whose mortality is the highest in the whole group of LBW infants.

At present it is well known that neither the total PMR, nor the LBW rate in spite of their relationship with one another are sufficiently objective criteria for the evaluation of the quality of perinatal care. E.g. in those newborns without nonviable malformations with a birthweight of $\leqq$ 2500 g of all the newborns, the perinatal mortality should be minimal with good perinatal care, since the most important causes of ante- and postnatal mortality (severe lethal malformations and LBW) would not apply. This indicator should therefore be a good criterion of the quality of basic perinatal care. It is apparent from table I that according to this indicator, the ranking of individual provinces is different from that shown if the total PMR is used as the sole indicator. For example by this indicator of the quality of basic

**Table I.** Results of the 1986 analysis of the quality of perinatal care in ČSR evaluated according to different criteria both countrywide and in individual provinces.

| | P | MB | SB | WB | NB | EB | SM | NM | ČSR |
|---|---|---|---|---|---|---|---|---|---|
| PMR per 1000 | 11.5 | 9.7 | 8.5 | 14.0 | 12.1 | 9.9 | 10.1 | 11.5 | 10.9 |
| LFDR per 1000 | 3.4 | 3.7 | 3.0 | 4.7 | 5.0 | 4.0 | 4.8 | 4.1 | 4.2 |
| ENDR per 1000 | 8.1 | 6.0 | 5.5 | 9.3 | 7.1 | 5.9 | 5.3 | 7.4 | 5.7 |
| PMR – share of nonviable malformations (NVM) per 1000 | 2.5 | 1.8 | 2.0 | 2.7 | 2.4 | 2.7 | 2.3 | 2.0 | 2.3 |
| PMR – share of ⩾ 2500 g without NVM per 1000 | .9 | 1.4 | 1.4 | .9 | 1.7 | 1.6 | 1.7 | 1.2 | 1.4 |
| LBWR % | 6.3 | 6.0 | 5.5 | 6.5 | 6.9 | 5.3 | 5.2 | 5.6 | 5.8 |
| CSR % | 8.6 | 6.7 | 6.9 | 5.4 | 5.9 | 5.4 | 5.4 | 5.4 | 6.5 |

PMR = perinatal mortality rate
LFDR = late fetal death rate
ENDR = early neonatal death rate
LBWR = low birthweight rate
CSR = caesarean section rate
P = Prague
MB = Midle-Bohemia
SB = South-Bohemia
WB = West-Bohemia
NB = North-Bohemia
EB = East-Bohemia
SM = South-Moravia
NM = North-Moravia

**Table II.** Development of specific early neonatal death rate in low birth weight newborns in ČSR in the last 5 years as compared with Sweden.

| Birth weight g | Specific early neonatal death rate | | | |
|---|---|---|---|---|
| | ČSR | | | Sweden |
| | 1981 | 1985 | 1986 | 1983 |
| ⩽1000 | 817 | 740 | 706 | 524 |
| 1000–1499 | 410 | 318 | 293 | 208 |
| 1500–1999 | 116 | 112 | 111 | 68 |
| 2000–2499 | 31 | 28 | 26 | 18 |

perinatal care, Prague together with West-Bohemia province are at the top of the rank order with a value of 0.9:1000. Using only the total PMR, however, which reaches a value of 11.5/1000, they would be only on the 5th–6th place. The East-Bohemien province, on the other hand, according to this indicator exhibits a value of 1.6/1000 putting it in seventh place whereas according to the total PMR it is one of the best highest 3 provinces in ČSR.

The so called weight-specific ENDR which is divided into individual birth weight groups in 500 g bands is at present acknowledged to the best objective criterion for the assessment of the quality of the care of LBW infants. In the last five years we have managed to decrease the weight-specific ENDR in the ČSR in the groups of very LBW and extremely LBW infants, but the weight-specific ENDR in the group 1500–2000 g remains almost unchanged. We note also that the weight-specific ENDR is strikingly higher in the ČSR in all birth weight groups in the year 1986 than the rate in Sweden in the year 1983 (table II). When comparing the weight-specific ENDR for LBW infants in individual provinces, we found significant interprocincial differences (table III. IV). Whereas the regions with the lowest weight-specific ENDR attain levels similar to the best results seen all over the world, the weight-specific ENDR in the regions with the poorest results considerably exceeds the countrywide average. These differences are closely related to three other factors that influence perinatal mortality:

The first of these factors is the difference in perinatal care. In the above mentioned 8 provinces, each of which is subdivided into approximately 10 districts (each with an average of 100 000 inhabitants), the perinatal care in every district is given by poly-clinics (one clinic per 7000 inhabitants) and by obstetric departments of hospitals (one to three in each district). These obstetrics departments are differentiated according to the degree of care for "at risk" and "non-risk" pregnant women and newborns into three different categories. The first one concentrates those pathological pregnancies of mothers from its own district and also from other districts of the province. In

addition its neonatal department has a neonatal intensive care unit (NICU). The second category receives the "at risk" pregnancies from its own district only, does not have its own NICU and therefore transports the high risk newborns to the neonatal departments of the first category. The third category receives predominantly "non risk" pregnancies, and since it does not have a NICU, the at-risk newborns are also transported to the neonatal departments of the first category. 35 out of 135 obstetric departments in ČSR are of the first category; 39% of the total number of 134 309 newborns delivered in ČSR in the year 1986 were born in these departments. Only 17% of obstetric departments are of the second category and 19% of newborn are delivered there. The most numerous are the obstetric departments of the third category (more than one half), and 42% of all newborns are delivered in these departments. The concentration of women with premature labour who delivered very LBW fetuses in the obstetric departments of the 1st category is documented by a higher percentage of LBW infants in these obstetric departments (7.6%), as compared with the obstetric departments in the third category (4.4%).

The mortality of these newborns in substantially lower, if they are delivered in obstetric departments of hospitals in the first category whose neonatal departments have a NICU, as compared to those newborns that are transported in an incubator to these same hospitals. If the fetus is transported "in utero", the weight-specific ENDR is strikingly lower (table IV). The differences, however, disappear in the higher birth weight groups.

The second, no less important factor that influences the quality of perinatal care and therefore also the PMR, is the availability of modern equipment. In this respect there exist striking differences between individual provinces. This is typically demonstrated by the example of the relationship between the number of deliveries and the number of cardiotocographs (fetal monitors). Whereas in Prague there is a ratio of one cardiotocograph to 471 deliveries, in South-Moravian and East-Bohemian provinces, the ratio of deliveries to each cardiotocograph is more than four times higher and in North-Bohemian province approaches a tenforld increase (figure 1). The availability of such equipment in each province correlates directly with the PMR of those newborns without non-viable malformations, whose birthweight was higher than 2500 g. Similar differences between individual provinces also exist for ultrasound equipment as well as for modern equipment used in NICU for the care of the neonate. Once again these corelate directly with the weight-specific ENDR of the very LBW newborns, in whom this dependence on equipment is greatest.

Different frequency and types of obstetric interventions represent the third factor. Different types of operative births and of inductions of labour are used. One such example is that of caesarean section rate (CSR) which varies between individual provinces from 5.3% to 8.6% with a countrywide average of 6.5% (table I). This places ČSR among those countries which have both a low PMR and

**Table III.** Interprovincial differences in the specific early neonatal death rate in low birth weight newborns in ČSR in the year 1986 (lowest and highest values) differentiated according to the birth weight.

| Birth weight g | Specific early neonatal death rate Interprovincial differences ČSR | | |
|---|---|---|---|
| | lowest value | highest value | average |
| ≦1000 | 571 | 813 | 706 |
| 1000–1499 | 200 | 339 | 293 |
| 1500–1999 | 72 | 122 | 111 |
| 2000–2499 | 13.6 | 36.9 | 26 |

**Table IV.** Weight specific early neonatal death rate in ČSR in the year 1986 differentiated according to the birth weight and to the type of obstetric department where delivery took place (NICU = neonatal intensive care unit)

| Birth weight | Obstetric department | |
|---|---|---|
| | with NICU per 1000 n | without NICU per 1000 n |
| ≦1000 liveborn | 201 | 113 |
| died | 66 | 85 |
| Weight specif. ENDR | 653 | 752 |
| 1000–1499 liveborn | 322 | 350 |
| died | 89 | 108 |
| Weight specif. ENDR | 276 | 309 |
| 1500–1999 liveborn | 733 | 856 |
| died | 69 | 108 |
| Weight specif. ENDR | 94.1 | 126.2 |

CSR. If we compare the total CSR to the birthweight, then, on the other hand, an increasing CSR with decreasing birth weight can be seen, and, on the other hand, an increased variation between individual provinces such that in the birth weight group 1000–1499 g this variation increases the CSR treefold i. e. from 10.0% to 29.8% (figure 2). In this group, after elimination of non-viable malformations, we also found a linear relationship between CSR and perinatal mortality of those fetuses and newborns in the sense of the share in the total PMR. A similar dependence was also found in the group of fetuses and newborns without non-viable malformations whose birthweight was ⩾ 3000 g (figure 3).

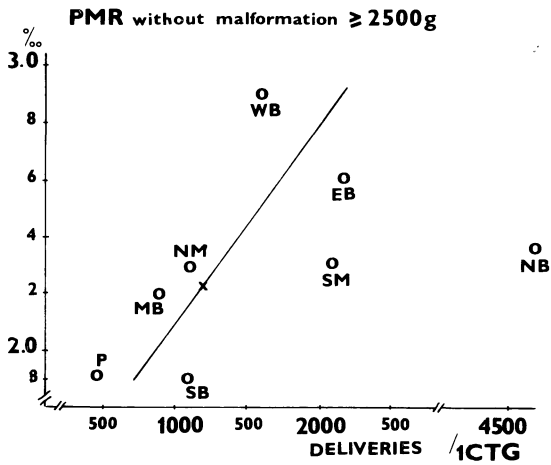


**Figure 1.** Correlation between equipment of the obstetric departments (cardiotocographs) as expressed by the ratio of deliveries/year to each CTG apparatus in individual provinces of the ČSR in the year 1986 and between the contribution to perinatal mortality of fetuses and newborns without nonviable malformations with a birthweight 2500 g and more to the total PMR.

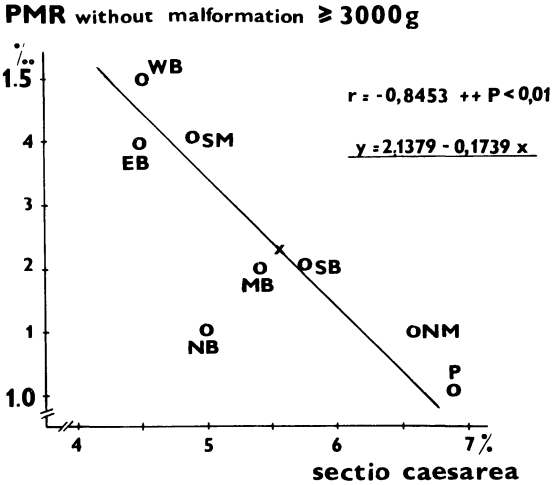


**Figure 2.** Correlation between caesarean section rate in individual provinces of the ČSR in the year 1986 and the contribution perinatal mortality of fetuses and newborns without nonviable malformations with a birthweight 3000 g and more to the total PMR.

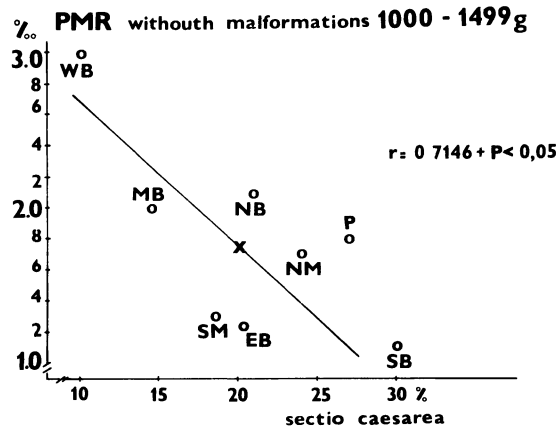


**Figure 3.** Correlation between caesarean section rate in individual provinces of the ČSR in the year 1986 and the contribution perinatal mortality of fetuses and newborns without nonviable malformations with a birthweight 1000–1499 g to the total PMR.

## 3 Discussion

In the introduction to this paper it was mentioned that one of the aims of the use of computers in perinatal medicine is to prepare a basis for optimal intervention strategy which would result in further improvement of perinatal care. This strategy is changing in different periods in accordance with the conditions, that exist as can be seen in the example of the development of PMR in ČSR in the course of the last 20 years (figure 4). A very slow decrease of PMR (by 0.26/1000 annually) in the period 1966–1976 demonstrate the reason for to initiate a detailed countrywide analysis as a basis to prepare for optimal interventions. This resulted in the countrywide introduction of differentiated care for high-risk pregnancies and newborns in the year 1976 that caused a fourfold acceleration of the decrease in PMR especially in the ENDR component in the subsequent three years. This was followed by a showing of this

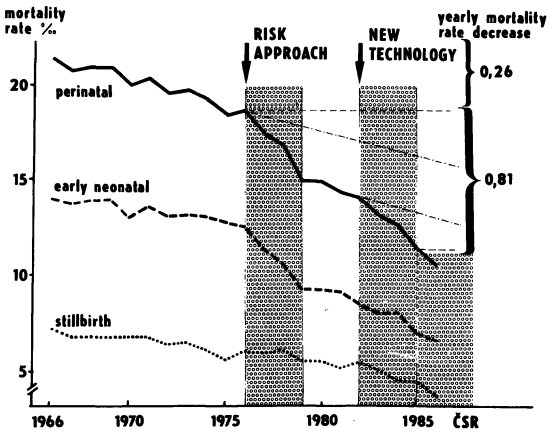


**Figure 4.** The effect of introduction of two intervention strategies ("Risk approach" and "New technology") into the clinical practice countrywide on the development of total perinatal mortality rate, early meonatal death rate and stillbirth rate in ČSR in the period 1966–1986.

decrease over two years and this constituted the reason for a new strategy which consisted of an increased use of new technology in perinatal care. This strategy has also led to a new acceleration of the PMR decrease that continues up to the present and has influenced both ENDR and LFDR. The aim of the most recently performed analyses is to find out now even before the fall in PMR slows down, whether all possibilities in the strategies we are using are already exhausted. The 1986 analysis has shoen that for each of them there exist certain disparities of degree and type in each of the provinces which, if corrected, will result in further improvement. The new strategy will be prepared in accordance with these results. The aim of this paper was not to present a proposal for details of a new intervention strategy in perinatal care in ČSR, but to demonstrate, how to obtain a basis for preparation of such a proposal using a computer.

**Summary**

The computer laboratory of the Research Institute for the Care of Mother and Child in Prague performs annual a countrywide analysis of perinatal outcome in order to obtain a background for the preparation of the optimal strategy for improving perinatal care in ČSR in the future. The total as well as weight specific perinatal mortality rate further sub-divided into early neonatal death rate and late fetal death rate and differentiated according to the birthweight, was correlated with the incidence of different factors influencing the perinatal mortality rate both countrywide and for each of the eight provinces of ČSR. This way a correlation was found between some of the mentioned perinatal outcomes and e. g. instrumental equipment of obstetrical departments and neonatal intensive care units, frequency of caesarean sections, or transport of LBW newborns in incubators or "in utero" etc. The results of this analysis have proved that there still remain in some provinces opportunity for further decrease in perinatal mortality due to the incomplete observance of the two intervention strategies "Risk approach" and "New technology" which were introduced in the whole country during the last 10 years.

**Keywords:** Intervention strategy, interprovincial differences, perinatal technology, perinatal mortality rate, weight-specific mortality

**Zusammenfassung**

**Perinatale Ergebnisse einer landesweiten Erhebung**

Das Rechenzentrum des Prager Forschungsinstitutes für Mutter und Kind erstellt jährlich die perinatalen Ergebnisse einer landesweiten Erhebung. Ziel dieser Erhebung ist es, die Hintergrundsinformationen für eine optimale Strategie zur Verbesserung der perinatalen Versorgung in der CSSR zu erhalten.

Sowohl die perinatale Gesamt- als auch die spezifizierte Sterblichkeitsrate wurden weiterhin in frühe neonatale und späte fetale Todesrate und nach dem Geburtsgewicht unterteilt. Beide Sterblichkeitsraten wurden mit dem Auftreten verschiedener Faktoren korreliert, die die perinatale Sterblichkeit sowohl landesweit als auch unterschieden für die acht Provinzen der CSSR beeinflussen. Auf diese Weise wurde eine Korrelation gefunden zwischen einigen der genannten perinatalen Ergebnisse einerseits und z. B. der instrumentellen Ausrüstung geburtshilflicher Abteilungen und Neonatologie-Intensivstationen, der Häufigkeit von Kaiserschnitten, dem Transport von LBW Neugeborenen in Inkubatoren oder „in utero" andererseits. Die Ergebnisse dieser Erhebung haben gezeigt, daß in einigen Provinzen noch „Reserven" für eine weitere Senkung der perinatalen Sterblichkeitsrate existieren; eine Sterblichkeitsrate, welche auf die inkonsequente Anwendung der beiden Interventionsstrategien „aufkommendes Risiko" und „neue Technologie" zurückzuführen ist; zwei Strategien, die in den vergangenen 10 Jahren im ganzen Lande eingeführt wurden.

**Schlüsselwörter:** Gewichtsspezifische Sterblichkeit, perinatale Sterblichkeitsrate, perinatale Technologie, regionale Unterschiede, Vorgehensstrategien

**Résumé**

**Analyse du devenir périnatal à l'echelon d'un pays**
Le laboratoire informatique de l'institut de recherche pour les soins de la mère et de l'enfant à Prague fait une analyse annuelle à l'échelon du pays du devenir périnatal afin d'obtenir un arrière plan pour la préparation d'une stratégie optimale pour l'amélioration des soins périnataux en Tchecoslovaquie dans le futur. La mortalité périnatale totale comme la mortalité spécifique ont été divisées en plus en mortalité néonatale précoce et en mortalité fœtale tardive et ont été différenciées selon le poids de naissance; La mortalité périnatale a été corrélée avec l'incidence de différents facteurs influençant le taux de mortalité périnatale à la fois au niveau national et également différenciées pour chacune des huit provinces de Tchécoslovaquie. De la sorte on a trouvé une corrélation entre les devenirs périnataux mentionnés et par ex. l'équipement instrumental des départements d'obstétrique et des unités de soins intensifs néonataux, la fréquence des césariennes, ou le transport des nouveaux-nés de faible poids de naissance en incubateurs ou « in utero » etc... Les résultats de cette analyse ont prouvé qu'il reste une place pour une diminution supplémentaire de la mortalité périnatale dans certaines provinces « préservées » du fait de l'observation inconséquente de deux stratégies d'intervention introduites dans l'ensemble du pays pendant les 10 dernières années, « l'approche du Risque » et « la nouvelle technologie ».

**Mots-clés:** Differences des provinces, mortalité périnatale, mortalité spécifique selon le poids de naissance, stratégie optimale, technologie périnatale

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